T H E E L E C T R O N

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ELECTRONICS OFFSHORE

Running concurrently with National Electronics Week were five other major engineering exhibitions, which included Air Tech 2014, Drives and Controls 2014, Fluid Power and Systems 2014, and Plant and Asset Management 2014. These exhibitions are well established and represent an important focal point for engineers across all disciplines.

The fifth exhibition was the inaugural European Offshore and Energy Exhibition, a new exhibition that fills a void in the European exhibition calendar and is supported by the new DFA Media journal *Offshore and Design Engineering Europe*, a bi-monthly pan-European journal that covers the design, procurement, engineering and maintenance requirements of the offshore industries, including oil and gas platforms, subsea, wind, wave, tidal and related equipment.

In addition to the journal a new comprehensive online hub, www.offshoreeuropejournal.com has been launched for professionals who are looking to keep up-to-date with the latest offshore technologies, in which electronics is playing a vital role.

Ryan Fuller, commercial director of DFA Media Energy Division, stated at the launch of the exhibition:

"The launch of the European Offshore and Energy Exhibition and Conference highlights how this is a booming sector, and we are confident the show will very quickly establish itself as a must-attend biennial event."

In this issue of The Electron an offshore focus is therefore presented, beginning with a look at how electronic technology enabled the effective monitoring of the Eyjafjallajokull volcano in Iceland.

WIRELESS ELECTRONICS MONITOR VOLCANIC ERUPTION

In April 2010 the Eyjafjallajokull volcano in Iceland disrupted air travel throughout Europe as a result of a hazardous ash cloud.

The seismic activity, lava flows and flash floods would have created a problem for hardwired connections in the area, but by using remote devices The Icelandic Meteorological Office was able to continue collecting and analysing data.

The system that was deployed used remote GPRS/EDGE cellular routers supplied by Conel, the Czech-based subsidiary of B and B Electronics that network-enabled sensors via Ethernet, USB or serial connections, and then transmitted the data via the cellular telephone network. Solar panels powered the equipment and their back-up batteries, removing the need to rely on vulnerable power lines.

Irrespective of whether the remote devices were old or new, or needed to communicate via Modbus or TCP/IP, the cellular router was able to accommodate them.

Only recently have cellular networks been able to serve as a wire replacement in such applications, which has considerable implications for the offshore industries. Whilst 3G systems could provide data rates of several Mbit/s, the specifications for the newer 4G LTE standards call for peak data rates of up to 100 Mbit/s for high mobility devices and up to 1 Gbit/s for low mobility devices. In addition, message latency, which can run in the hundreds of milliseconds for 3G, improves to tens of milliseconds over 4G LTE. This kind of throughput enables cellular networks to serve as a true replacement for long-range cabling.

Cellular networking, however, requires the purchase of a data plan, and for local wireless connections Wi-Fi is usually the most cost-effective option. Until recently the potential of Wi-Fi has been limited by issues such as multipath propagation, whereby radio waves are absorbed or reflected by objects in their path such that transmitted signals arrive at the receiver at different times and out of sequence. The higher the radio frequency the worse the problem is.

Lower frequencies, however, provide less bandwidth and require larger antennas and more power to produce useful gain.

Fortunately the 802.11n Wi-Fi standard now addresses this through the application of Multiple-Input-Multiple-Output (MIMO) technology that utilises multiple antennas at both the transmitting and receiving sides of the wireless connection, and splits the data into numerous special streams. These streams are transmitted through separate antennas and collected by corresponding antennas in the receiving devices, where onboard software use signal processing algorithms to correct and interpret the incoming data.

Another technique that is deployed is spacial beamforming, which modifies the phase and relative amplitude of the signal to create a pattern of constructive and destructive interference in the wavefront, which simplifies interpretation on the receiving side.

The 802.11n standard also adds frame aggregation to the MAC layer, making it possible to specify management information less frequently by grouping several data frames into a single, larger frame. As the ratio of payload data to total data volume is higher, throughput is improved.

The 802.11n standard has now been augmented with the IEEE 802.11ad or 'WiGig' standard that makes available a tri-band Wi-Fi option. Using 60Ghz this standard provides a theoretical maximum throughput of up to 7 Gbits/s.

The article 'Safely monitoring a live Volcano' by Mike Fahrion, Director of Product Management for B and B Electronics, is featured in the April 2014 issue of *Instrumentation* journal (ISSN 1472-1260), subscriptions £85, from ConnectingIndustry, London Road, Maidstone, Kent ME16 8LY. Telephone: 01622 687 031.

More information about the instruments is available from www.bb-elec.com

MONITORING BOIL-OFF ON LNG TANKERS

In recent years the demand for Liquefied Natural Gas (LNG) has increased significantly. In order to be transported, however, the gas has to be cooled to –163 degrees Centigrade at atmospheric pressure to make it liquid. The insulation of the tanks on board the transportation vessels, however, is not perfect and during the voyage some boiling inevitably occurs.

LNG tankers are commonly powered by steam turbines with dual-fuel boilers that can use the boil-off gas, but operators have to accurately measure the amount of boil-off gas used in the ship's engines as part of the MARPOL Annex VI regulations that govern marine propulsion.

In order to address these requirements Allison Engineering have developed the ST range of flow meters that use the thermal dispersion principle whereby the temperature difference is measured between active (heated) RTD and a reference (unheated) RTD. This is greatest in a no-flow condition and decreases as the flow increases, cooling the heated RTD. Changes in flow velocity and density directly affect the extent to which heat dissipates and, in turn, the magnitude of the temperature difference between the RTDs. The flow meter thus measures mass flow directly without the need for additional temperature and pressure corrections.

The ST110 flow meter that is specified for the LNG boil-off application has the ability to be functionally tested and calibrated without the need to remove the sensor from the pipeline. It features an integral purge tube that runs the length of the sensor and allows the operator to generate a known flow across the sensor element. The resultant signal output can then be compared to the factory baseline test certificate.

The ST110 is constructed in 316 stainless steel for the housing and Hastelloy C for wetted parts, with control options via 4-20 mA signal, HART, Profibus PA and

Fieldbus H1 as required. It can also operate at process temperatures up to 450 degrees Centigrade and offers a turndown ratio of 1000:1.

A related instrument is the ATEX certified STP100, the only insertion thermal dispersion gas flow meter that uses pressure measurement to create a triple function solution. This provides flow, temperature and pressure in a single tap point insertion instrument. All three parameters are available using 4-20 mA signals or Fieldbus H1 or Profibus DP.

This article, 'Gas Flow Meters set for Life on the Ocean Waves' is also featured in the above journal and information about the product may be obtained from Allison Engineering on 01268 526 161.

CONDITION MONITORING OF OFFSHORE WIND TURBINES

Wind power has been identified by the Government as one of the key technology platforms for enabling the UK to achieve its carbon emissions and climate change targets. Wind turbines, however, do have their problems, particularly when it comes to rotor blades, which are notoriously accident prone in harsh conditions.

Wind turbine rotor blades can be expensive to replace and condition monitoring therefore becomes an important activity to ensure that the turbines remain operational. This can be difficult in offshore locations such as the North Sea, which has just a three-month service and maintenance window each year.

The most common causes of defects tend to be excessive load, lightening damage and ice formation, and when faults develop the rotor blades need to be shut down quickly to prevent damage from escalating.

Until recently the condition monitoring of wind turbine rotor blades has been achieved either with dual anemometers (one heated) or by monitoring the ambient conditions in an attempt to predict, for example, when ice is likely to form. Neither method is accurate, however, and an inordinate amount of power generation can be lost as turbines are shut down and physical inspections undertaken, especially in winter.

A more modern approach is to use the natural oscillation of a turbine blade to determine its true condition, and to use a 'Blade Control' system to signal to either the operator or machine control if there is a problem such as structural blade damage, ice accretion or lightning damage. This system can also track the history of a blade's condition so as to offer a 'forensic trail' of a wind turbine's performance.

The system works by performing an analysis of the natural oscillation frequencies of the turbine blade, which change when the blade is damaged or has an increased dynamic load through ice accretion. Each blade has its own frequency distribution that can vary in a range up to about 350 Hz. The frequency distribution is therefore like a 'fingerprint' of the blade.

When ice forms on a blade it gains weight and the oscillation frequency slows down. As a result specific frequency peaks become visible on a monitor and structural damage can be spotted within the low frequency range. Minor damage, by contrast, is only visible in the higher frequency range. Thus slight rotor blade damage, such as multiple trailing edge cracks, will not affect the spectrum between 0 Hz and 50 Hz, but visible changes will be noticeable between say 150 and 250 Hz.

The technology utilises accelerometer sensors (multi-dimensional piezo-electric accelerometer sensors), which are glued directly into the rotor blades. A data collector in the hub converts the analogue, measured oscillations into digital values which are then transmitted from the hub into the nacelle via WLAN. The digital data is then interpreted by the 'Blade Control' embedded processing unit.

The data is recorded online and evaluated in detail in the system's embedded processing unit in real time. If, at any point, an extreme event occurs, such as serious damage to the blade or ice formation, the control system will be immediately informed that the turbine is to be shut down. The fact that the blades are being monitored locally even when stationary also enables an auto-restart to be initiated when, for example, all the ice has cleared. This can remove the need for an engineer to visit the site and minimises lost power generation.

Benefits of the system are the introduction of a planned, rather than a reactive, maintenance programme and a payback period of less than two years.

The article 'Tip-top Condition' by Stuart Williams, Renewable Energies Control Products Manager for manufacturer Bosch Rexroth, is published in Issue 3 (February 2014) of *Offshore Design and Engineering Europe*, edited by Aaron Blutstein and published by DFA Media. Subscriptions are currently £100 per year (UK). Head Office: DFA Media Limited, 192 High Street, Tonbridge, Kent TN9 1BE. Telephone: 01732 370 340. Email: info@dfamedia.co.uk

More information about the product is available on the website www.boschrexroth.co.uk

ADDRESSING HYDRAULIC HOSE FAILURE

Unexpected hydraulic hose failure is a major problem in the oil and gas industry, with the two most common causes being internal fatigue due to impact cycles and impact abrasion.

In the past operators have tended to address the problem by replacing hoses according to a fixed schedule, but this can be both costly and wasteful as hoses are frequently replaced with over half of their safe working life still remaining.

In order to address this a research project was initiated between electronics manufacturer Eaton and Purdue University to identify measurable, structural phenomena associated with hose deterioration over time and thence to develop a system that will enable reliable condition monitoring to be achieved.

The research concluded that hydraulic hose failure is the final step in a consistent process that can be measured and therefore monitored to provide a reliable indication of an impending end-of-life situation. An intelligent condition monitoring system was then developed to detect failure-related events within such hoses.

The resulting LifeSense system uses the fact that certain properties of a hose change as it approaches failure. Periodic comparison of samples with a baseline provided a reliable indicator of imminent hose failure.

Each hose fitting is equipped with a sensor that continually monitors hose conditions via electrical signals, which are then sent to a hose diagnostic unit that then interprets the data.

The hose diagnostic unit runs on 12 V dc or 24 V dc and can monitor up to 11 hose assemblies, and a range of standard wire cable lengths are available to accommodate different applications from 3m to 300m. A wireless option with a gateway that can monitor up to 100 hoses with a 433 Hz frequency communication protocol is also available.

The sensors, which have a greater than six year battery life, continually monitor the hose and the gateway transmits operating performance data to a secure server once every seven hours. Should an issue arise the gateway the gateway transmits data immediately. A web portal then provides advanced system monitoring giving maintenance teams access to specific data, such as hose installation date, trend reports and diagnostics management.

Tests showed that assemblies potentially achieve up to 50 more service life than expected.

This article is also featured in the above journal and further product information may be obtained from www.eaton.com/hydraulics

IMPROVEMENTS IN INTERNAL WELD INSPECTION

Global expenditure on pipeline construction and servicing is expected to reach £216 billion over the next five years with over 270,000 km of new pipeline expected to be installed. A major problem, however, is corrosion and while Corrosion Resistant Alloy (CRA) clad pipe provides a partial solution the welding process is critical to the successful fabrication of pipeline.

Assuring the quality of welding of pipeline joints is crucial to the welding process and in order to meet the challenge that this poses Hertfordshire-based Optical Metrology Services has developed an internal weld inspection system.

The new system bridges an important technological gap in the measurement of CRA welds, such as HiLo (joint misalignment), weld height and width, and lack of penetration of fusion.

Video-only inspection can result in pipe joints having to be cut out in order to mitigate risks, even if they turn out to be acceptable on closer inspection. Ultrasonic inspection can be used, but it can only be performed after the weld has been fully completed, meaning that there have to be multiple weld passes before finishing the cap of the weld. As a result, if a flaw is found it may take many hours of work to rectify it, adding to wasted time and expense.

The system from Optical Metrology Services, known as WeldChecker, is placed inside the pipe and is able to move through it and inspect the welds after just the second pass. If a flaw in the root weld is discovered it can be cut out immediately, saving time and money.

Another major advantage is the system's ability to inspect welds around curved pipes, which are particularly common in subsea structures such as Pipeline End Terminators (PLETs) and Pipeline End Manifolds (PLEMs). For these the WeldChecker utilises a concept similar to that of the 'bendy bus' that allows previously inaccessible welds to be to be measured for compliance.

Further developments have also allowed deployment in very narrow pipes, e.g. with a 100 mm internal diameter, such that it is now possible to use both laser and visual measurement techniques in both narrow pipes and those that incorporate tight bends.

Next steps include mounting of the tool to the line up clamps for use in the critical welding path both onshore and offshore during pipeline welding, and development of the system for the inspection of tie-in welds on welded spooled stalks of pipe. The latter will mean that while these pipes are spooled onto the vessel, the WeldChecker will be driven by a crawler. Other potential applications include use on older pipes and structures to measure the extent of corrosion or pitting, and the measurement of the extent of features in the pipe wall.

This article, entitled 'Pipe Welding Problems solved?' is featured in the April 2014 issue of *Eureka: The Magazine for Engineering Design*, edited by Paul Fanning (ISSN 2049-2324), subscriptions £81 (UK), published by Findlay Media, Hawley Mill, Hawley Road, Dartford, Kent DA2 7TJ. Telephone: 01322 221 144. www.eurekamagazine.co.uk

Further information concerning the product is available from www.omsmeasure.com

APPLICATIONS FOR HALL EFFECT ROTARY-POSITION SENSORS

Hall effect rotary-position sensors are designed to measure the angle position of a moving element by using a magnetic field instead of mechanical brushes and dials. They use a magnetically-biased Hall effect integrated circuit that senses rotary movement of the actuator shaft over a set operating range. Rotation of the actuator shaft changes a magnet's position relative to the integrated circuit. The resulting flux density change is then converted to a linear output, which can then be used to provide feedback to either an operator or a vehicle subsystem.

Solid-state Hall effect technology provides non-contact operation. The internal section of the sensor uses a magnetic field rather than the physical brush or wiper that is used in potentiometers, which is prone to friction. Hall effect rotary-position sensors can therefore reduce the number of worn out mechanisms, lower actuation torque and extend product service life.

The wide range of potential applications for these sensors has been an important topic of discussion recently, particularly in the transport sector. One such application is the replacement of mechanical cable connections between a foot pedal and an engine. Whilst the mechanical cable may stretch or rust, thereby requiring regular maintenance and recalibration, the Hall effect sensor does not, and by eliminating the mechanical cable, the engine control system response is improved, along with emissions, reliability and excess weight.

In such an application the rotary-position sensor can be mounted adjacent to the pedal so as to measure how far down the pedal is pressed. The harder the operator presses, the deeper the pedal is depressed, allowing more fuel and air to be delivered to the engine, thus accelerating the vehicle. When the foot is removed from the pedal the sensor senses the change in position and sends a signal to the engine to reduce the flow of fuel and air across the throttle plate.

In a related application in buses the sensors may be used to ‘sense’ the travel of the suspension system. Buses use ‘kneeling’ systems to lower their height so that passengers can board easily, and the sensors can be used to both measure the position of the control lever and to monitor ride height through deployment on a suspension arm or linkage.

Accurate position sensing verifies that the vehicle is at the correct height for the application system’s requirement, improving vehicle ingress/egress. Large trailer trucks may also use the sensors to monitor trailer heights to improve warehouse docking efficiency.

On speedboats the sensors can be used to monitor tilt/trim position. The sensor accurately reports the angle position of the propeller, which can help the operator to avoid damage and maintain optimum performance.

Offshore the sensors are particularly useful for controlling process valves. Oil fields, for example, require that valves accurately monitor positions, and these sensors can be used to monitor position in large and small valves to help ensure that the valve is closed or, if open, how open.

The article ‘Finding the right Application’ in the above journal features further applications.

Further information about the sensors and their uses may be obtained from www.honeywell.co.uk

NEW FLUID PRESSURE SENSOR FOR PROCESS CONTROL

There are many applications for which the accuracy and repeatability of a dispensed amount of a fluid is critical, and traditionally verification of the dispensed amount has been achieved by measuring the system pressure. This is because, all other factors being the same, the pressure is directly related to the flow rate. Comparison of pressure with time can therefore be used to provide quality assurance that the correct amount of fluid has been dispensed.

Pressure monitoring and analysis can also reveal issues that may affect fluid flow, such as unwanted air bubbles, obstructions caused by contamination, clogging due to agglomeration of fillers, and variation in feed pressure.

Until recently, however, pressure sensing technology has been limited to flush mounted fluid pressure sensors that require the insertion of an adaptor into the line carrying the fluid, and this has a weakness, namely that it can cause ‘dead space’ or undercuts that can potentially distort pressure readings and impede cleaning.

Another disadvantage is the diaphragm, often made of stainless steel, that is incorporated into the design. This sensing diaphragm is in constant contact with the fluid and can react with it, to the extent that special treatment is needed to make the device usable.

In an attempt to overcome these deficiencies a new piezo-resistive sensor has been developed. This incorporates an elastomer that transfers the force created by the pressure to a measuring cell. Challenges that have been overcome include:

- Vulcanising of the thin elastomer diaphragm within the very narrow tolerance range required.
- Integrating of the elastomer into the small geometry of the sensor housing.
- Connecting the elastomer to the measuring cell (many other sensors transfer the force using oil).

The fluid channel within the sensor has also been coated with an FFKM perfluoroelastomer, which provides an inert and impervious internal seal, and transmission of the internal pressure. This fluid channel design has no ‘dead space’ or undercuts, and provides optimal resistance to aggressive compounds such as hydrocarbons.

The sensor utilises the Luer lock industry standard so simplifying its installation in many systems, with small dimensions aiding implementation where space restrictions may apply. A standard calibrated linear 0-10 V output signal is provided via an integrated cable and a standard M8 connector. The millivolt signal generated at the source is converted to this signal by means of an integrated amplifier, obviating the need for an external transducer or booster, and it is internally stabilised within the operating temperature range of 15 to 45 degrees Centigrade. The 0-10 V output is a

standard control signal, readily utilised by PLC-based automation or test and measurement systems.

The article ‘When you have to know your Process is right every Time’, by Peter Swanson, Managing Director of Intertronics, is featured in the March 2014 issue of *Industrial Technology*, edited by Mark Simms. Copies are available from IT Magazine, Victoria House, 2 Mornington Road, Sale, Cheshire M33 2DA. Telephone: 01732 773 268. Email: it.info@itmagazine.co.uk.com

Information about the product may be obtained from www.intertronics.co.uk

UNLOCKING THE POTENTIAL OF SMART GRIDS AND RENEWABLE SYSTEMS

The move from large centralised power generation systems towards the mass roll-out of renewable generation systems is creating new challenges for the monitoring, protection and control of power systems, particularly in relation to keeping the network stable during the transition. Network operators especially need greater awareness of the state of the grid at both transmission and distribution level.

The new conditions require that network protection is more robust, discriminative between fault and non-fault conditions, and quicker to respond. Present-day instrumentation has been found to be lacking particularly when distributed power generation and energy storage produce power flows that are two-way and highly changeable.

Present-day systems for the monitoring and protection of power systems typically compare currents entering and leaving a designated zone in order to ascertain if they differ. They require measurement systems (powered and housed indoors) that are located near to measurement points. Centralised protection is not possible. For complex networks or where increased sensor coverage is required, this can be impractical and highly costly.

Fortunately a system originally designed for monitoring voltage and current on electrical submersible pumps in harsh oil and gas industry environments has been able to be adapted in order to overcome some of the obstacles. This has been achieved by retrofitting the technology to existing sensors and protection relays, drastically reducing costs and improving functionality.

Optical fibre sensors were developed which can be ‘chained’ along a single telecoms fibre. The measurement is analogue all the way to the sampling point at the interrogator, meaning that there is no digital communication and no bandwidth bottleneck. The sensors are therefore networked and interrogated in a highly efficient manner, reducing the dedicated infrastructure requirements.

A key application already exists for the technology where one utility provider operates a transmission line that is primarily guided above ground but dips underground at three locations. Existing protection systems should try to switch on

again when faults are above ground, e.g. caused by lightning strikes. If, however, the fault is below ground then it is most likely due to insulation breakdown and reclosing this can be very dangerous. At present operators are unable to identify whether the fault is above or below ground because they are unable to install standard sensors along the line.

As the sensors can operate over very long distances and do not require power sources they can be installed where the cable dips and so allow operators to determine immediately if the fault is located above or below ground. This has resulted in lower network downtime, fewer customers offline and substantial cost savings.

The potential for this technology was recognised earlier this year by The Royal Academy of Engineering and The Academy's Enterprise Hub Scheme is now producing a year's worth of training, funding and business mentoring from Atkins Energy CEO Martin Grant and Professor John Marsh of The University of Glasgow. This will help to get the technology to market through Synaptic Limited, a spin-out of Strathclyde University.

The technology is described by Dr. Philip Orr, a post-doctoral research associate at Strathclyde University in the Spring 2014 issue of Energy Management, available from ConnectingIndustry, London Road, Maidstone, Kent ME16 8LY. Telephone: 01622 687 031.

Information on the product is available from info@synapt.eu

ADVANCED INSTRUMENTATION PROTECTION FOR GAS PROJECTS

Intertec Instrumentation has announced that it is to supply 120 environmental protection cabinets to house online process analysis instrumentation on Shell's Prelude floating liquefied natural gas vessel.

The vessel, which has a length of 488m and a width of 74m, is designed to liquefy natural gas extracted from subsea wells by cooling it to –162 degrees Centigrade and then store it until it is offloaded onto large LNG carriers. It is due to enter service in 2017 and will be towed to the Prelude and Concerto gas fields in the Browse Basin, some 200km off the north-west coast of Australia, where it will be anchored for about 25 years.

The intended operating environment for the vessel requires advanced instrumentation protection techniques, the Basin having an average temperature of 32 degrees Centigrade as well as high humidity and a salt-laden atmosphere that makes components prone to rust damage. In confined spaces the ambient temperature may exceed 50 degrees Centigrade.

A total of 90 cabinets are to be deployed for sample conditioning systems and 30 for the process analysis. Each is designed to match the instrumentation content and layout precisely in order to optimise thermal performance.

The cabinets are constructed from a proprietary composite material comprising of sandwich walls of long-fibre glass reinforced polyester (GRP) sheets that enclose a core of polyurethane foam. This provides a similar strength to that of stainless steel, but is four times lighter, which is a major benefit for offshore platforms and floating structures.

The advanced design of the cabinets allows them to withstand a severe Category Five tropical cyclone with wind speeds of over 157 m.p.h. as well as providing strong corrosion resistance both from the salt-laden air and from sour or acid gas. Importantly, the cabinets also allow the electronic equipment to be cooled without recourse to explosion-proof air conditioning systems.

The external surfaces of the cabinets are coated with a thick layer of UV-resistant gel and for the wind speed requirements each cabinet is equipped with special built-in mountings (which are external to the thermally insulated parts of the enclosure) to secure the top and base to Prelude's deck structure.

All external metal components are fabricated from 316 stainless steel with a corrosion-resistant protective coating that is specified for ship use.

Each cabinet incorporates semi-passive cooling technology. The internal face of the rear walls are fitted with a high-efficiency heat exchanger, comprising one or more aluminium cooling plates and stainless steel cooling pipes connected to Prelude's cold water supply system. Heat dissipated by the equipment in the cabinets is absorbed by the water and transferred to the vessel's main water cooling system where it is dissipated to the environment. The size of each cabinet depends on the power dissipation of the contained sample conditioning or process analyser system, which ranges from 140W to 900W.

All of the cabinets are designed to keep their internal air temperature below 35 degrees Centigrade.

Further Applications

Intertec has also supplied shelters to protect SCADA systems, comprising remote terminal units (RTUs), telemetry equipment and associated electronics, for the control infrastructure of a new gas pipeline on the coast of the Persian Gulf.

These shelters need to protect against both salt and chlorine in the atmosphere and sulphur from the natural gas. In summer the equipment has to be able to withstand high levels of UV radiation and daytime temperatures of up to 55 degrees Centigrade in the shade.

Two of these shelters are close to the electricity grid and can use active cooling, but a third was required to protect instrumentation in a remote location where all instrumentation power is derived from inverters fed by batteries that are recharged by means of a photovoltaic generator. This particular shelter therefore has a strict power

budget such that even though the shelter has a large volume (142 cubic metres), the cooling system has to be entirely passive.

This shelter was thus designed with two walk-in rooms with their own entry doors. One room contains the rechargeable batteries, whilst the second houses all of the system instrumentation and electronics, including a PLC, computer network, power inverters and a controller for the external photovoltaic generator.

The passive cooling technology is based on thermo-siphoning using water, which is cooled and heated using the natural variation of day and night temperatures. The rear of the equipment room houses an 8,000 litre thermally stratified water tank connected to two closed-loop thermosiphon systems formed by internal wall-mounted and external roof-mounted heat exchangers. The water circulates using just natural convection.

The article 'Housing Solutions for the Gas Industry' is featured in the March 2014 issue of Design Solutions (ISSN 1740-2654) obtainable from ConnectingIndustry as above.

Information about the protection systems is available from www.intertec.info

MAGNETIC ROTARY ENCODERS FOR INDUSTRIAL ROBOTS

Industrial robots can repeat movements millions of times with accuracy down to fractions of a millimetre, but for this to be achieved accurate sensors are required.

Until recently optical rotary encoders have been used to provide the necessary sensor accuracy, but now a magnetic rotary encoder, which combines both the Hall and Wiegend effects, is able to monitor the position of the axes to 0.1 of a degree with a resolution of up to 16 bits.

For complex operations the movements of the six axes on each robot have to be in precise harmony with each other. The key to precision lies in the robot's drive and each robot arm axis has its own motor. The axis rotation triggered by the motor is recorded by a rotary encoder. The signals from all six sensors are compiled and evaluated in the controller. Since the tolerances of individual axes in a single cascade add up to an overall tolerance, sensor accuracy is crucial.

Until now robot manufacturers have had to decide whether they wanted to install a highly accurate sensor or a compact and robust sensor. Conventional magnetic sensors and resolvers are compact and tough, but are limited in accuracy. The alternative, high-precision optical sensors, whilst more accurate, tend to be affected by dust, vibration and temperature fluctuations. The Pepperl and Fuchs magnetic encoder, however, solves this dilemma.

The Hall sensor with two axes provides the singleturn absolute value. Its rotating magnetic field generates a sine/cosine signal, which is processed by the internal processor. The process value balances out the output value of an absolute rotary

encoder with optical scanner. This design allows singleturn absolute sensors to feature such compact dimensions that have hitherto not been possible.

The Wiegend sensor provides the multiturn absolute value. A rotating permanent magnetic field above the Wiegend sensor generates a change in the direction of the magnetic field in the sensor's core. In turn an induction voltage is produced in the coil that is wrapped around the sensor. Each time the direction of the magnetic field is changed, i.e. twice per revolution, energy is provided that is used to electronically count revolutions and to supply power to the electronics.

With the Wiegend sensor it is no longer necessary to have an integrated battery to power the electronics, such that a power failure does not pose a problem to the rotary encoder. There will be complete data protection even in emergency situations.

The article 'Robust Precision for Industrial Robots: New Options with Magnetic Rotary Encoders' by Stefan Horvatic, Head of Rotary Encoder Product Management, Factory Automation Division for Pepperl and Fuchs, is featured in the March 2014 (Vol. 40, No.3) issue of *Industrial Engineering News*, edited by Jurgen Wirtz. www.ien.eu

Information about the product is available from Pepperl and Fuchs (GB) Limited on 0161 633 6431. www.pepperl-fuchs.co.uk

SMART INTERCONNECTION AIDS INDUSTRIAL INTEGRATION

The concept of an 'integrated industry' involves the interaction of a wide range of components and systems, from simple interconnection devices and sensors, through Radio Frequency Identification (RFID) systems, to MES and ERP software systems.

The approach to this that is now being adopted combines the use of RFID, which gives products an identity, with embedded devices that offer the capability to record measurements and make simple decisions even at the field level. So-called 'middleware' has been developed to bridge the gap between hardware and software, and service-oriented architecture offers customers long-term cost minimisation.

Industrial integration on such a level incorporates modular structures that require multiple and often complex connector interfaces. Asset management, for example, requires connector interfaces that are entered, catalogued and identified for maintenance and operational work.

These requirements can now be met by equipping connectors with small UHF RFID transponders so as to provide the necessary data-collection functions and integrate them into a highly efficient data management system. By linking data from real components on production machines to the virtual world of IT management an identification spectrum can be created that spans everything from specific connector and configuration data through to the ordering of spare parts.

A mobile reading device, such as a smart phone with an associated reading unit, can be used to record component data and compare it with data from an e-Business database. Immediately upon identification spare parts or reference values can be displayed and used.

These systems are noted for their time and cost savings, as well as their ability to prevent costly mistakes such as incorrect spare parts being ordered during maintenance work, and in order to support them a SAP-based e-Business solution has been developed to enable reliable and rapid access to detailed data on products and machinery that can be used for further integration with business and production processes.

A major challenge has been to perfectly integrate transponders in an environment in which metallic surfaces cause reflections, and to provide data media that can withstand harsh environments, but this has been achieved with the latest generation of RF transponders. Increased memory employing the 'write once' function also allows secure and permanent of a type of memory to a component, and hence its own history, and, with the latest chip technology, there is even the ability to allow components to perceive their own ambient conditions.

The result is intelligent process technology in which RFID technology is enabling the self-optimisation and self-diagnosis of components such as connectors. Since data can now be dynamic, i.e. the progression through a process can be stored in memory, essential pre-requisites for the self-configuration of process technology have been met.

Further advances in terms of object-specific data collection and storage are now being worked on.

The article 'Smart Interconnection' by Kevin Canham, Product and Applications Manager at Harting, is featured in the March 2014 issue of *Electronics: Products and Applications for Electronics Design*, available from ConnectingIndustry as above.

Information about the smart interconnection technology may be obtained from Harting Limited on 01189 817 391 or 01604 827 500. Email: gb@harting.com

WEARABLE COMPUTING

Wearable computing systems have for many years been difficult to integrate into industrial environments, but technological advances in areas such as pervasive wireless, smartphones and tablet PCs are now making this otherwise marginalized form of electronics more practical for a variety of industrial applications.

Major players such as Google, Google Glass, Apple and SAP are now looking to market in this area, and in Europe The European Commission's wearIT@work programme is underway with 42 partners, a funding of 14 million Euros and four industrial pilot applications in production, maintenance, healthcare and the emergency services.

So far the pilots have shown that wearable computers help to prevent mistakes, enable workers to work faster and more efficiently and reduces the length of time that workers, particularly on assembly tasks, need to be trained.

The assembly pilot tests were conducted using a Xybernaut V computer, Microoptical SV6 HMD and a conventional headset, with a VNC client application, to allow remote control and interaction with a wearable application for 14 assembly procedure steps. The tasks in this area highlighted the need for the wearable devices to be unobtrusive for good multimodal interaction, for a collaboration mechanism, and for fast tracking via mobile sensors to ensure that tasks were performed correctly, with help and suggestions provided via the headset.

The maintenance pilot demonstrated how wearable computing could increase the mobility of workers in geographically dispersed production plants and improve the availability of task information, knowledge sharing and training, with multimodal interaction through voice and gestures. Maintenance operators were equipped with a modular maintenance vest configured with cutting-edge hardware components, input and output devices for hands-free working, voice and gesture-based interaction, with advanced knowledge management functionality. Team members with remote support said that work quality and cooperation improved with new audio-visual tools and on-the-job decision support.

In the healthcare case it was found that wearable computing can improve the availability of information for doctors and nurses on ward rounds. Wearable computers were equipped with input devices for gesture recognition, RFID scanners and proximity sensors for communication with fixed infrastructure such as bedside displays and tablet PCs used by medical staff.

The main breakthrough came with the development of the head-mounted display, but the challenge is integration of information obtained from the wearable system into the overall IT infrastructure. Mere transfer of the desktop interface onto an HMD with speech input used instead of typing is insufficient. A carefully integrated system with a specific text or graphical user interface is needed.

In response to the challenge Vuzix have introduced the M100 monocular display, which uses the Android operating system and provides an integrated camera, audio system and processor in a hands-free format. This operates with most Android apps and is both Bluetooth and WiFi supported, running with or without cloud connection.

The M100 can be used with an adjustable over-the-head band or clipped-on safety glasses to access, record and review data. In partnership with Nokia Vuzix is also introducing a super-thin Waveguide lens that can project full-colour, augmented-reality images over surroundings using V200OAR glasses.

A further requirement for wearable computing is provision of information that can be consumed easily, and a need to improve hypertext reading has been identified. ‘Hypermedia’ is therefore being used to integrate wearable computing into existing processes and software.

Currently theory is being put into practice at Daimler where a hands-free multi-order picking system called Xpick has been prototyped and is under test. This can be used with an HMD, tablet PC on a picking cart or on a wrist-worn computer. A special user interface can be used with different error reduction modules for intelligent pick weight matching, cart location, integrated barcode scanning and voice-based operation. The HMD uses a wireless LAN with various picking scenarios and a graphical user interface.

Another application is 3D motion tracking systems for humans and machines for industry, entertainment and movement science. For this the Xsens MVN has been developed, which is a camera-less system with 17 inertial sensors for motion capture that is used for digital posture and gait measurement in industry and in film and animation. These systems are wireless motion trackers equipped with micro electronic mechanical sensors (MEMS). Inside each tracker are three MEMS accelerometers, three MEMS gyroscopes and a magnetometer. The motion trackers can calculate the 3D orientation of each tracker and where it is heading. The information is fed into a computer where a biomechanical model defines the orientation of the model or animated character.

Fiat and Jaguar Land Rover are currently using Xsens for ergonomic analysis of new production lines and for assessing human interaction with new car designs in combination with Catia or Delmia software and Siemens' Jack or Process Simulate Humans system. Embraer in Brazil is also using Xsens to design new aircraft production lines.

The article 'Ready to wear' by Brian Davis is featured in the Electronics section of the March 2014 (Vol 27 No.3) issue of Professional Engineering, edited by Lee Hibbert. Copies are available on 020 7045 7500 or Email: pe@caspianmedia.com